19th European Biomass Conference and Exhibition
From Research to Industry and Markets
ICC Berlin - International Congress Center Berlin - Germany • Conference 6-10 June 2011 • Exhibition 6-9 June 2011

DETERMINATION OF OPTIMAL SUBSIDIES FOR BALANCING LOCAL SUPPLY/DEMAND OF BIOMASS PRODUCTS WITHIN A REGIONAL DEVELOPMENT STRATEGIC PLAN

F.A. Batzias[1], O. Kopsidas[1] and Y.Pollalis[2]
[1]Laboratory of Simulation of Industrial Processes, Department of Industrial Management and Technology,
[2]Department of Economic Sciences
University of Piraeus
Karaoli & Dimitriou 80, 18534 Piraeus Greece
Tel.: +302104142368; Fax: +302104142392; email: fbatzi@unipi.gr

Scope of the Work

Under the assumption that energy crop farmers believe the price in the previous period will prevail in the current period as well, adjusting their cultivation species accordingly, the biomass market may exhibit instability. In the present work, optimal subsidy I_{opt} is determined for balancing local supply/demand of biomass products for avoiding such instability while ensuring adequacy of biomass inventory for feeding continuously a biomass processing unit. The I_{opt} model is implemented for parameter values referring to Greek biomass-to-energy market, which appears to be a developing sector although the economy (as a whole) is in recession during the last two years. It is also shown that optimization of the subsidy required to balance local supply/demand of biomass products depends on capacity optimization of the biomass processing plant under consideration, within a strategic plan for regional development that should put emphasis on (i) the improvement of the rural roads network to minimize transportation costs and (ii) the diffusion of information about conditions recommended for biomass storing in open air to avoid enzymatic hydrolysis which deteriorates the quality of raw material and decreases the efficiency of the processing unit.

Introductory Analysis

Biomass demand for downstream products may exceed the supply corresponding to market equilibrium as expected before harvesting (e.g., to obtain an energy crop). In such a case (i.e., when the supply actually harvested falls short of the intended supply), the market period supply (MPS) function, or the corresponding curve in the familiar Quantity Q – Price P diagram, shifts to a below equilibrium (denoted by Q_0 for price P_0) output of Q_1, generating an above equilibrium price of P_1. Thinking that this price is going to remain in the next agricultural period, farmers plan an above equilibrium output of Q_2, which, in its turn, assuming their intentions are exactly realized, generates a below equilibrium price of P_2, and so on. The repeated cycles corresponding to successive agricultural periods, may lead either to convergence towards an equilibrium or to divergence contributing to market instability, as shown in Fig. 1, according to the ‘Cobweb’ model, also known as ‘Cobweb Theorem’ in Economics.

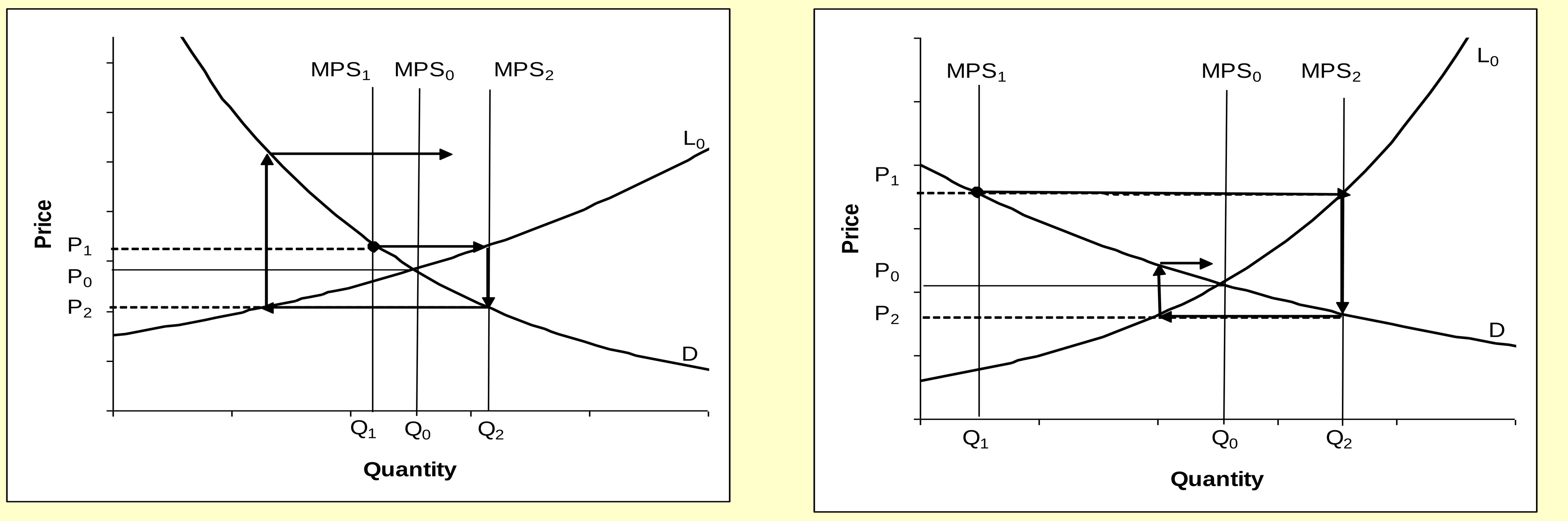

Figure 1: Application of a Cobweb model to energy crop leading to (top) divergence, i.e., market instability, since the elasticity of demand is lower than the elasticity of supply and (bottom) convergence, i.e., market stability, since the elasticity of demand is higher than the elasticity of supply.

Implementation

An implementation of I_{opt} determination is subsequently presented for parameter values referring to Greek biomass-to-energy market, which appears to be a developing sector although the economy (as a whole) is in recession during the last two years.

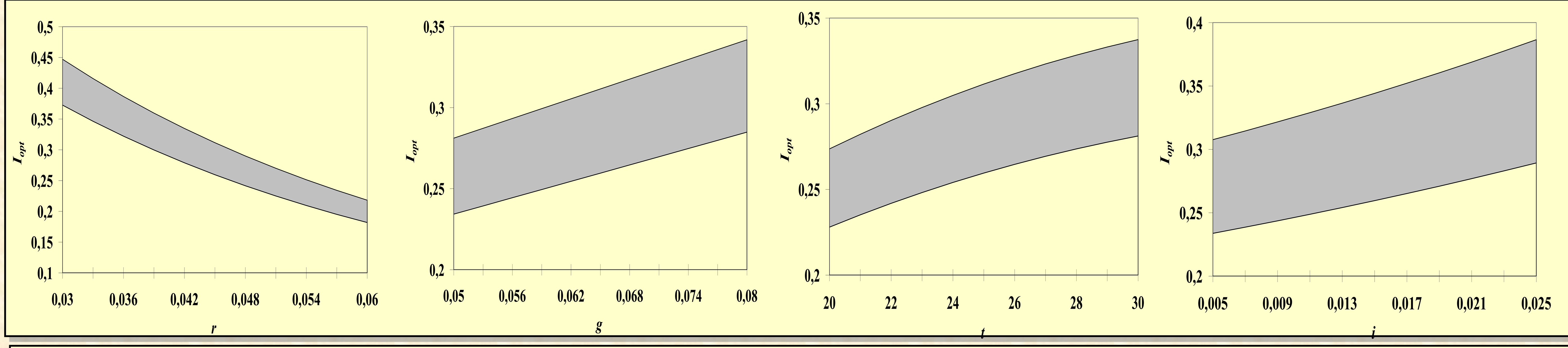

Figure 2: Monoparametric sensitivity analysis indicating the dependence of optimal subsidy I_{opt} on *r*, *g*, *t*, *i*, for range values representative of the Greek biomass-to-energy potential market.

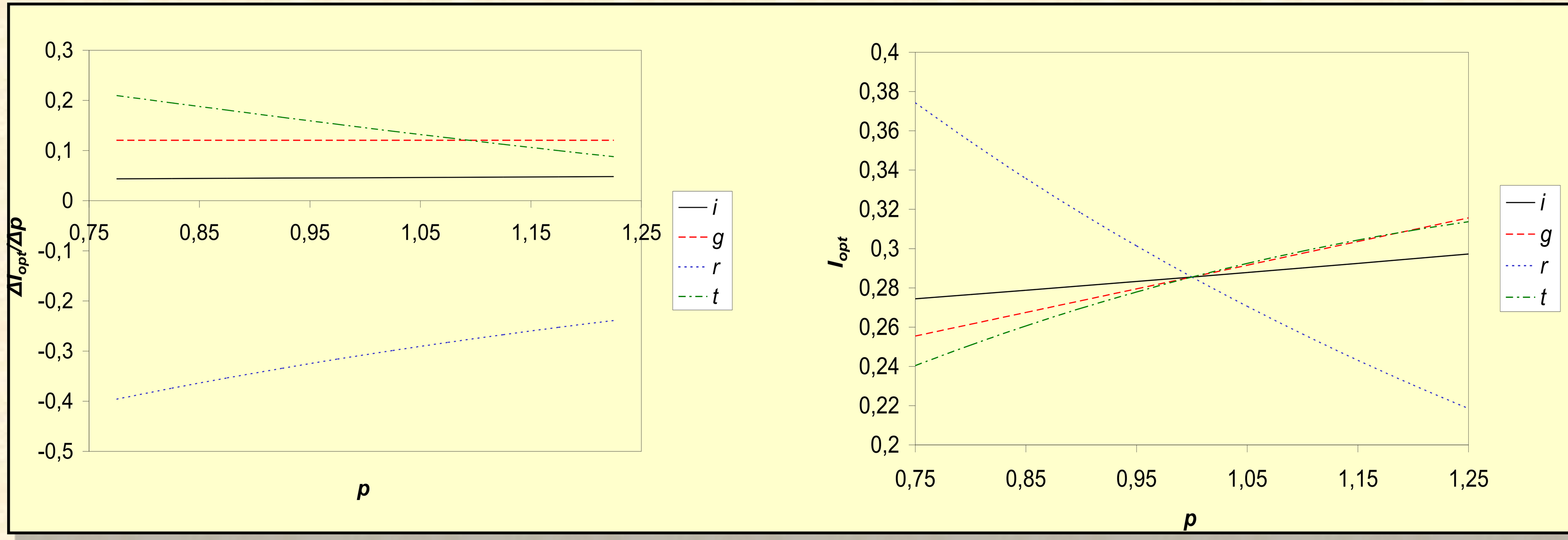

Figure 3: First and second order sensitivity analysis (top and bottom diagram, respectively) of optimal subsidy *Iopt* in the region *P*0±0.25*P*0, where *P*0 is the mean value of parameter *P* (i.e., *r*, *g*, *t*, *i*); on the horizontal axis, the dimensionless values *p*=*P*/*P*0 are quoted.

Discussion and Concluding remarks

The capital *S* required for the investment is a function of the biomass processing capacity *C* of the industrial plant under consideration. The optimal value *Copt* can be determined as an equilibrium point in the trade off between expenditures *E*1 for biomass transportation and *E*2 for biomass processing. The first variable, *E*1, is an increasing function of *C* with an increasing rate (i.e., $dE1/dC>0$ and $d2E1/dC2>0$), since higher *C*-values require transportation from longer distance in order to form the biomass inventory that is necessary for continuous fuel production; moreover, the expenditure for biomass collection is proportional to the area, which is cover by either cultivated energy plants or lignocellulosic residues, and this area is a parabolic function of distance from the processing industrial unit, implying non-linear dependence of *E*1 on *C*. On the other hand, the second variable, *E*2, is a decreasing of *C* with an increasing algebraic or decreasing absolute rate (i.e., $dE2/dC<0$ and $d2E2/dC2>0$ or $d|dE2/dC|/dC<0$) because of the validity of the exponential function giving the intensity of scale economies, which are more expressed in the region of low *C*-values, as shown in the next paragraph. The *Copt*-value is determined at $Emin = (E1+E2)min$ or $d(E1+E2)/dC = 0$ or $ME1=ME2$, where $ME1=dE1/dC$ and $ME2=|dE2/dC|$ are the marginal values of *E*1 and *E*2, respectively. In case of significant oil price increase, implying respective increase of transportation cost, the *E*1-curve moves upwards becoming steeper at the same time, because increase is expected to be more expressed in the region of high *C*-values corresponding to longer distance form the biomass processing unit; since this industrial unit is located at the most accessible point, the transportation effort per distance unit increases implying higher fuel consumption in countries like Greece where the quality of rural roads network worsens significantly when we go away from urban areas. As a result, *Copt* is shifting to *C΄opt*, where *C΄opt*<*Copt*, as shown in Fig. 4a. On the contrary, if this network is expected to be improved in the near future by a corresponding provision within regional development strategic plan, the *E*1-curve will eventually move downwards becoming more flat at the same time, because of the transportation cost decrease, which is most likely to exhibit larger differences in the region of high *C*-values for the reason quoted above; as a result *Copt* is shifting to *C΄΄opt*, where *C΄΄opt*>*Copt*, as shown in Fig. 4b.

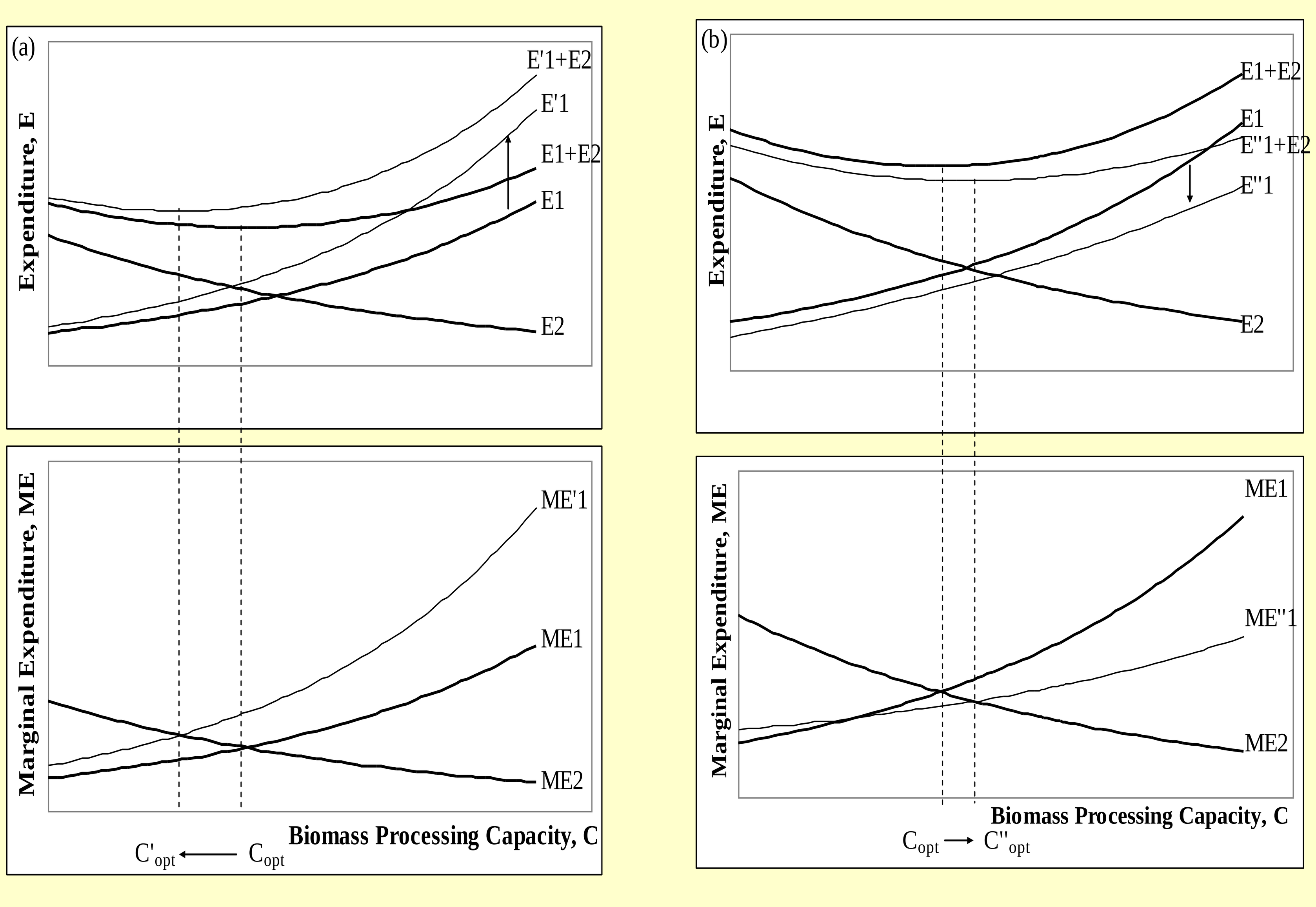

Figure 4: Dependence of biomass transportation expenditure *E*1 on shifting of optimal biomass processing capacity *Copt* in case of (a) significant oil price increase and (b) rural roads network improvement within a regional development strategic plan.

ACKNOWLEDGMENTS: Financial support provided by the Piraeus University Research Centre is kindly acknowledged.